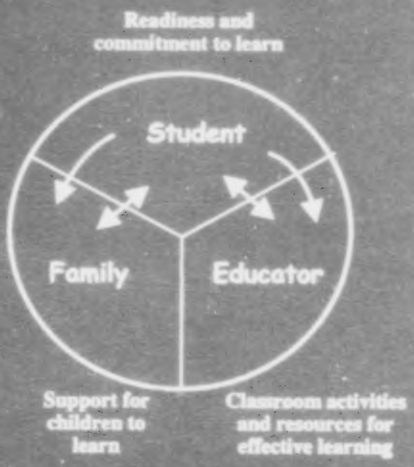

Saskatchewan Opportunities to Learn in Science

1999

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Saskatchewan Education

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INTRODUCTION

LEARNING SCIENCE IN SASKATCHEWAN: THE CURRICULUM

The major aim of Saskatchewan's K-12 science program is to develop scientific literacy in students. Scientifically literate students know that science is a way of understanding the world and that they can apply scientific concepts in everyday life.

Students come into science classrooms with experience in identifying, prodding, manipulating, and investigating many phenomena. Bicycle riders have practical experience with the physics of force, motion, balance, momentum, and friction. They also have learned to infer much about their surroundings through visual cues. How deep and muddy is the puddle? How soft is the path?

A good science program builds on such experiences. Science students develop skills and attitudes to create conceptual maps of the world around them. They realize these conceptual understandings are tentative, subject to questioning, and revised through investigation. Valued scientific skills and attitudes include the desire to know, the curiosity to observe, the propensity to ask questions, the determination to seek answers, the creativity to design investigations, the ability to measure and manipulate, and the ability to interpret findings and apply them to other situations.

Science teachers foster these skills and attitudes by:

- encouraging and assisting students to create questions about what is around them;
- giving students an opportunity to explore and to discover answers to questions they create; and,
- asking students to analyze, compare and evaluate the answers they discover.

This activity-based approach facilitates the goal of science education: to help students make better sense of the world in which they live, not merely to repeat others' descriptions of that world.

A scientifically literate student will be able to:

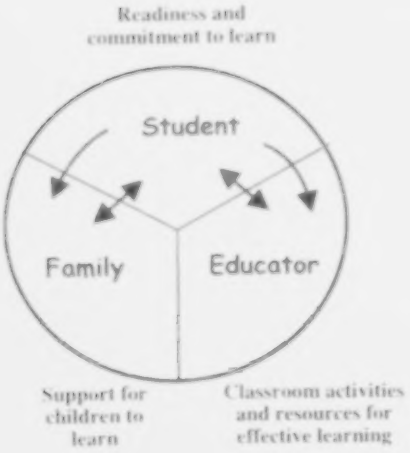
- understand the nature of science and scientific knowledge as a unique way of knowing;
- understand and accurately apply appropriate science concepts, principles, laws and theories in interacting with society and the environment;
- use the processes of science in solving problems, making decisions, and furthering understanding;
- understand and appreciate the joint enterprises of science and technology and the relationships of these to each other in the context of society and the environment;
- develop numerous manipulative skills associated with science and technology, especially with measurement;
- interact with the various aspects of society and the environment in ways that are consistent with the values that underlie science; and,
- develop a unique view of technology, society, and the environment as a result of science education, and continue to extend this interest and attitude throughout life.

Source: Saskatchewan Education. (1993). Science: A curriculum guide for the middle level. Regina, SK. (Introduction) www.sasked.gov.sk.ca/docs/midlscience/intromac.html

WHAT IS *OPPORTUNITY TO LEARN?*

Student achievement outcomes are affected not only by student ability, but also by differences in student experiences. The school, home, and student contribute to developing skills, attitudes, values and processes enabling students to question and analyze the world around them. Providing students with the opportunity to be scientifically literate citizens is a shared responsibility.

Opportunity to Learn is a shared responsibility in a social context.



- Schools and teachers must create a safe, non-discriminating environment to support learning. They engage students in active learning, providing effective instruction using a variety of high-quality resources, and guided by good curricula.
- Students must show a commitment and readiness to learn. They develop scientific literacy as they choose to participate, reflect on how they might enhance their skills, and persist to do their best work.
- Parents must support their children as they learn. They discuss academic progress and school experiences with their children, promote curiosity and a desire to learn, ensure necessary resources are available, and help and encourage their children.

Comparisons of achievement outcomes with students' opportunities are made throughout this document. The reader should not assume a causal relationship between the opportunity element and the achievement results. Nor should the reader assume an opportunity element to be unimportant if it does not closely relate to student outcomes. Opportunity elements represent relevant factors for enabling students to become scientifically literate. They are not necessarily factors that predict student performance on one written or practical science test. There may be many intervening factors contributing to student outcomes in the assessment.

Opportunity to learn refers to the conditions that facilitate learning.

Outcomes describe the product or results of learning such as the skill levels demonstrated by students.

Achievement comparisons are available for both 13- and 16-year-olds who participated in the national 1999 School Achievement Indicators Program Science Assessment. For both adequate and higher level performance, 13- and 16-year-olds, those with opportunity approximating the standard and those with sub-standard opportunity, are compared.

WHAT SCIENCE OPPORTUNITY ELEMENTS WERE CONSIDERED?

A variety of elements were considered in the 1999 study of opportunity to learn in science. These included:

- Classroom-related opportunities to learn:
  - frequency with which students experience hands-on activities in science classrooms;
  - curriculum implementation in the science classroom;
  - instructional approaches for learning science in the classroom; and,
  - availability and use of resources for learning science in the classroom.
- Student-related opportunities to learn:
  - time spent at home working on science;
  - preparation for class, attention to class activities and reflective practices; and,
  - student persistence and quality of work in science.
- Family support-related opportunities to learn:
  - home support for students' learning in science; and,
  - home support for students' learning in general.

Separate panels, including both educators and non-educators, were formed for each of Grades 5, 8 and 11 to discuss and set standards for these opportunity elements.

Standard-setting panels reviewed and selected statements they thought best defined sufficient learning opportunity. The statements from which they could choose, along with student and teacher response rates, appear throughout this report. These statements describe different types of behaviour or support and do not necessarily represent equal intervals on a continuum. Because standard-setters' responses were averaged, the standard was often a decimal number. A standard of 4.3, for example, means that the standard-setters' average response fell between statement 4 and statement 5.

The standards derived by these grade panels for each opportunity-to-learn element appear in the rest of this document. For the most part, standard-setters believed most students should have the opportunity at school and at home, as defined by the standards.

Data on student opportunity to learn in science came from two sources:

- About 1000 Grade 5 students and 50 Grade 5 science teachers completed questionnaires about attitudes and experiences related to learning science, as part of Saskatchewan's *Provincial Learning Assessment Program*.
- About 3500 thirteen- and sixteen-year-olds participated in the national *1999 School Achievement Indicators Program Science Assessment*. Their teachers (about 400) completed questionnaires including Saskatchewan-developed supplementary opportunity-to-learn surveys.

Students participating in the national assessment also completed written or practical tests in science. Student achievement on these tests will be reported in a separate document. No data for student achievement in science was collected in 1999 for Grade 5 students.

CLASSROOM-RELATED OPPORTUNITIES TO LEARN

Students' experiences in the classroom and in the school as a whole have a strong influence on their learning. The type of instruction, the curriculum used, and the books, videos, computer programs, laboratory facilities and other resources available all contribute to students' learning opportunities.

Classroom-related opportunities considered were:

- frequency with which students experience hands-on activities in science classrooms (Figure 1-1);
- curriculum implementation in the science classroom (Figure 2-1);
- instructional approaches for learning science in the classroom (Figure 3-1); and,
- availability and use of resources for learning science in the classroom (Figure 4-1).

- **Most students had opportunity to investigate science through hands-on activity. However, few Grade 11 classrooms provided opportunity as frequently as expected.**
- **More than four-fifths of Grade 11 classrooms and about half of Grade 5 and 8 classrooms covered all Core Curriculum units.**
- **About one-quarter of classrooms met standards for instructional approaches.**
- **Resource accessibility and use increased at higher grade levels. At Grade 5, thirty-eight percent of classrooms met standards; at Grade 11, fifty-seven percent did.**

HANDS-ON ACTIVITIES IN SCIENCE

Saskatchewan's K-12 science curriculum is activity-based. It invites students to learn about science by investigating the world around them and by working with equipment and materials. Teachers reported on the frequency with which students experience hands-on activities in the science classroom. Discussion at the standard-setting session raised some interpretation issues related to this question.

First, it was evident that teachers define "hands-on" in various ways. For most teachers, this term means students handling and using materials such as measuring equipment and biological specimens, whether at their desks, in a lab or in the natural environment. For a few teachers, this term means any activity other than studying the textbook or taking notes, and includes teacher demonstrations and videos. Other teachers consider "hands-on" to mean only those activities that occur in a laboratory.

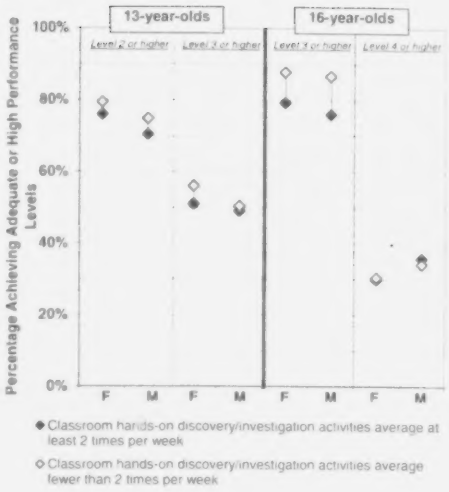
Second, standard-setters noted that teachers reported on the frequency with which hands-on activities occurred, not the amount of time spent on them. Students often spend only part of a class doing a hands-on activity. On other occasions, they may do two different hands-on activities in one class, or spend more than one class doing one activity.

Finally, school schedules may affect teacher responses about frequency of hands-on science activities. Many middle schools have an alternating day schedule (students take science every other day, which works out to be two or three times per week). Many high schools are semestered (students take science every day for five months). These two scheduling arrangements affect the weekly frequency of instructional approaches.

The results shown in Figure 1-1 are best interpreted within these alternate interpretations. Figure 1-2 compares student test outcomes from the 1999 SAIP science written test based on the frequency with which they experience hands-on activities.

Figure 1-1: Students' Experience With Hands-on Science Activities, 1999 Provincial Opportunity-to-Learn Teacher Survey

During a regular week, how many times do your students experience hands-on activities to discover or investigate science concepts?	Frequency (%) of Teacher Responses		
	Grade 5	Grade 8	Grade 11
Never	6.4	2.9	2.0
Once	76.6	62.6	44.2
Twice	10.6	25.7	35.0
Three times	6.4	5.8	14.7
Four or more times	0.0	2.9	4.1
Standard: Times per week	**1.19**	**1.38**	**4.0**
% of classrooms meeting the standard	**79%**	**73%**	**4%**



Figures 1-1 and 1-2 show that:

- Standard-setters affirmed students should have opportunity to discover or investigate science concepts through hands-on activities more than once a week, or in the case of Grade 11 students, four times a week.
- Almost all teachers reported providing opportunity for students to experience hands-on activity in science. About three-quarters of Grade 5 and 8 science classrooms provided opportunity consistent with the standard. Although hands-on activity was more frequent in Grade 11 classrooms, few classrooms offered frequency of this activity consistent with the 4-times-a-week standard.
- On the 1999 science written test, greater percentages of students in classrooms averaging fewer than two hands-on activities a week achieved higher levels.

How to interpret the achievement charts:

Group having opportunity approximating the standard under-performed

Group having opportunity approximating the standard out-performed

CURRICULUM IMPLEMENTATION

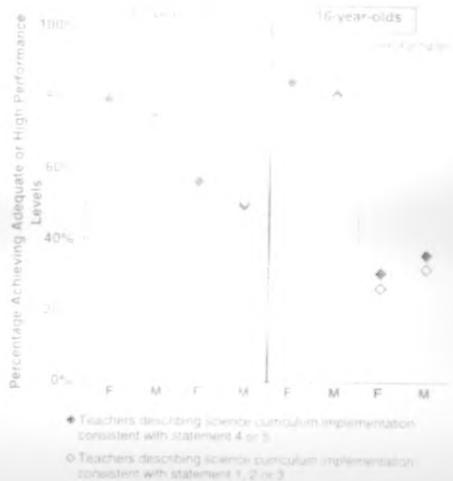
Curriculum implementation has several dimensions including:

- the extent to which the concepts in the curriculum are covered and developed;
- the extent to which instruction reflects the philosophy of the curriculum – the values, processes and attitudes integral to the curriculum;
- use of a variety of teaching and student evaluation techniques as suggested by the curriculum; and,
- the extent to which the Adaptive Dimension was used to meet individual student needs.

Teachers reported about curriculum implementation selecting the statement that best described the situation in their classroom. Figure 2-1 presents these statements and shows the percentage of teachers choosing each one. Figure 2-2 compares student

test outcomes from the 1999 SAIP science written test based on how the science curriculum is implemented in their classrooms.

Which one of the following choices best describes the extent to which students are exposed to the curriculum in your science classroom?	Frequency (%) of Teacher Responses		
	Grade 5	Grade 8	Grade 11
Statement #1 – Little coverage of the science curriculum occurs in my classroom.	0.0	0.6	0.0
Statement #2 – Only some of the units described in the curriculum are covered, but not in great depth or breadth.	0.0	7.6	0.5
Statement #3 – We cover key concepts of most core units described in the curriculum, but do not have opportunity to develop student proficiency in processes, skills, and values in science.	48.9	40.7	15.2
Statement #4 – All core units of the curriculum are taught so students develop concepts, processes, skills, and values reflective of the dimensions of scientific literacy.	34.0	33.7	58.4
Statement #5 – All core units of the curriculum are taught, with appropriate adaptations to meet individual needs and to optimize students' scientific literacy development.	17.0	17.4	25.9
Standard: Statement #	**4.13**	**4.13**	**4**
% of classrooms meeting the standard	**47%**	**47%**	**84%**



Figures 2-1 and 2-2 show that:

- It is expected that all core units be taught so that students will develop the concepts, processes, skills and values reflective of the dimensions of scientific literacy. This was done in the majority of Grade 11 classrooms and in about half of Grade 5 and 8 classrooms.
- For the 1999 SAIP written science test, there were no significant differences in the performance of students based on the extent to which the science curriculum was implemented in their classrooms.

INSTRUCTIONAL APPROACHES

Some of the instructional approaches used by science teachers include:

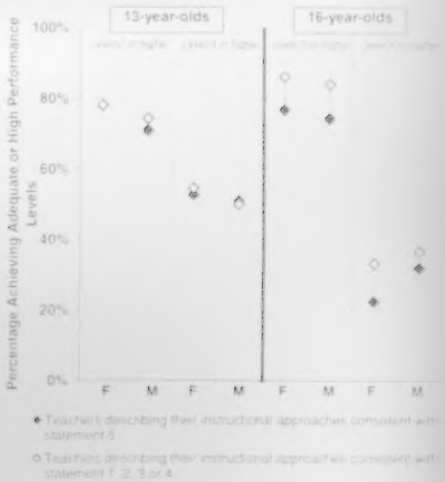
- asking students to read the textbook and take notes;
- showing videos;
- facilitating discussions and debates;
- facilitating students' use of computer programs;
- organizing group projects;
- organizing activities that involve manipulation of material and equipment; and,
- making it possible for students to experience scientific phenomena in the real world through field trips and outdoor activities.

Teachers are expected to adapt their teaching strategies to reflect the needs of individual students or groups of students. They are also expected to use strategies appropriate for the topic being taught. Student interest in science and the amount of student learning often depend on the instructional approaches used.

Figure 3-1 shows the percentage of teachers responding to statements that describe the instructional approaches used in their science classroom. Figure 3-2 compares student outcomes for the 1999 SAIP science written test based on instructional approaches in the classroom.

Figure 3-1: Instructional Approaches in Saskatchewan Science Classrooms, 1999 Provincial Opportunity-to-Learn Teacher Survey

Which one of the following choices best describes the approaches used to facilitate science learning in your classroom?	**Frequency (%) of Teacher Responses**		
	Grade 5	**Grade 8**	**Grade 11**
Statement #1 – Little time is allocated for learning science in my classroom.	0.0	0.0	0.0
Statement #2 – My students learn science primarily through copying notes, reading a textbook, and doing assigned questions.	8.5	4.1	1.5
Statement #3 – My students learn science through copying notes, reading print resources, doing assigned questions, and completing prescribed hands-on activities and investigations.	63.8	61.6	55.0
Statement #4 – My students learn science through an inquiry approach, exploring and investigating curriculum-relevant concepts that intrigue them.	4.3	9.9	5.6
Statement #5 – A variety of approaches are used and adapted to meet individual student's needs.	23.4	24.4	27.9
Standard: Statement #	**4.88**	**5**	**4.88**
% of classrooms meeting the standard	**24%**	**24%**	**29%**



Figures 3-1 and 3-2 show:

- Standard-setters expect a variety of instructional approaches to be used in the science classroom, and that these approaches be adapted to meet individual student's needs. This occurred in about one-quarter of Grade 5, 8 and 11 science classrooms.
- There is little difference in performance on the 1999 written science test by 13-year-olds, based on reported instructional approaches. The group of 16-year-olds from classrooms reporting use and adaptation of a variety of instructional approaches, did not perform as well as their counterparts.

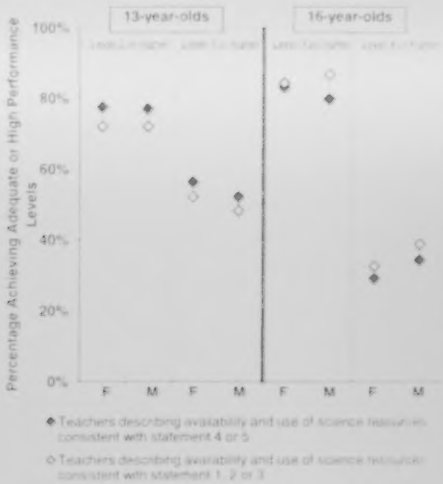
AVAILABILITY AND USE OF RESOURCES

Instructional resources include print resources such as textbooks, electronic resources such as videos and computer programs, and lab equipment such as microscopes and beakers. At the standard-setting session, there was a discussion regarding the definition of "lab equipment". Some believed it meant access to a separate, fully equipped science lab; others thought it meant a supply of basic equipment that students can use in the classroom. These different definitions should be considered when interpreting the following results.

Figure 4-1 shows the percentage of teachers responding to statements that describe the availability and use of resources for their classrooms.

Figure 4-1: Saskatchewan Science Classroom Resource Availability and Use, 1999 Provincial Opportunity-to-Learn Teacher Survey

Which one of the following choices best describes the availability and use of resources for teaching science in your classroom?	**Frequency (%) of Teacher Responses**		
	Grade 5	**Grade 8**	**Grade 11**
Statement #1 – Very few relevant and current resources are available for use.	0.0	1.7	1.0
Statement #2 – I use textbooks and print resources, but lab equipment is not available or used to investigate and learn science.	6.4	4.1	1.5
Statement #3 – Restricted availability and use of lab equipment and other resources allow students to discover and investigate only a few science concepts during the year.	51.1	36.6	16.1
Statement #4 – Lab equipment and other resources are available and used to allow students to discover and investigate the main science concepts of the course.	34.0	41.9	55.8
Statement #5 – Lab equipment and other resources are available and used to investigate concepts, support inquiry and do a range of science projects.	8.5	15.7	25.6
Standard: Statement #	**4.13**	**4.25**	**4.44**
% of classrooms meeting the standard	**38%**	**47%**	**57%**



Figures 4-1 and 4-2 show that:

- At a minimum, it is expected that lab equipment and resources be available and used to investigate the main concepts of the science course. This was more likely to be the case in Grade 11 classrooms (57 percent) than in Grade 8 classrooms (47 percent) or Grade 5 classrooms (38 percent).
- Student outcomes on the 1999 written science test, based on availability and use of resources in science classrooms, showed different patterns for 13-year-olds than for 16-year-olds. Overall, 13-year-olds in well-equipped and utilized science classrooms performed better than their counterparts. The reverse was true for 16-year-olds. In most instances, the differences were small.

WHAT DO YOU THINK?

- What constitutes a hands-on activity?
- How long should hands-on activities last?
- How frequently should hands-on activities be scheduled?
- How do we do in our school? Do we promote activity-based learning in science?
- The percentage of classrooms that met the standard for instructional approaches was low (between 24 percent and 29 percent). How can we support teachers in using and adapting a variety of instructional approaches to meet individual student needs?
- What instructional resources are available in our school?
- Can we pool/share instructional resources and activities within our school/school division to better facilitate activity-based learning in science?
- The presence or absence of achievement differences related to some of the classroom-related opportunity elements seem surprising.
  - Why do you think students in classrooms exposed to a variety of instructional approaches, and those experiencing frequent hands-on activities had overall lower performance on the 1999 written science test?
  - What other factors might explain these results?
  - What implications, if any, does this have for how students learn science in our school?

STUDENT-RELATED OPPORTUNITIES TO LEARN

Students' achievement depends on innate ability, but it also depends on other factors that are within the control of the student such as persistence, the willingness to work hard and completion of homework.

The student-related opportunities considered were:

- time spent at home working on science (Figure 5-1);
- preparation for class, attention to class activities and reflective practices (Figure 6-1); and,
- student persistence and quality of work in science (Figure 7-1).

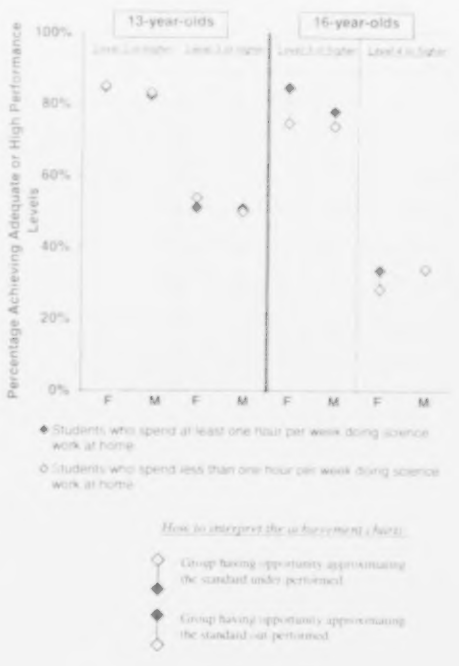
- **Expectations for student time working on science at home doubled from 0.8 to 1.6 hours per week from Grade 5 to 11. About one-half of Grade 5 students and one-third of Grade 11 students met these standards.**
- **A greater percentage of Grade 8 students than either Grade 5 or 11 students met expectations in preparation for class and reflection upon their learning.**
- **Greater percentages of Grade 5 students than Grade 8 or 11 students described themselves as working hard to show their best work in completing most science assignments.**

TIME SPENT ON SCIENCE AT HOME

Working on science at home, either through completion of homework, reading or viewing science materials, or personal investigation of the natural world promote students' further learning.

Students reported on the amount of time they spend working in science at home (preparing, doing homework, working on projects). Figure 5-1 shows their responses and Figure 5-2 shows science test achievement outcomes related to time spent doing science work at home.

In a regular week, what is the amount of time you spend at home working on science (preparing, doing homework, working on projects)?	Frequency (%) of Teacher Responses		
	Grade 5	Grade 8	Grade 11
No time	15.7	11.3	13.6
Some time, but less than one hour	43.3	45.0	35.2
1 to 2 hours	30.0	29.5	29.6
2 to 3 hours	6.4	10.0	13.5
3 to 4 hours	2.0	2.2	5.6
More than 4 hours	2.6	2.0	2.5
Standard : Hours per week	**0.8**	**0.94**	**1.61**
% of students meeting the standard	**52%**	**47%**	**33%**



Figures 5-1 and 5-2 show that:

- Grade 5 students are expected to spend, on average, 0.8 hours per week on science homework. Grade 8 and 11 students are expected to work at home on science for almost one hour and 1.6 hours per week respectively.
- About half of Grade 5 and 8 students spent the expected time doing science homework; one-third of Grade 11 students satisfied the higher standard for Grade 11. Over 10 percent of students spent no time working on science at home.
- There is no clear pattern evident in student achievement in the 1999 assessment based on time spent doing science homework. The group of 16-year-olds who spent at least one hour per week doing science homework showed slightly better results.

STUDENT PREPARATION AND REFLECTIVE PRACTICES

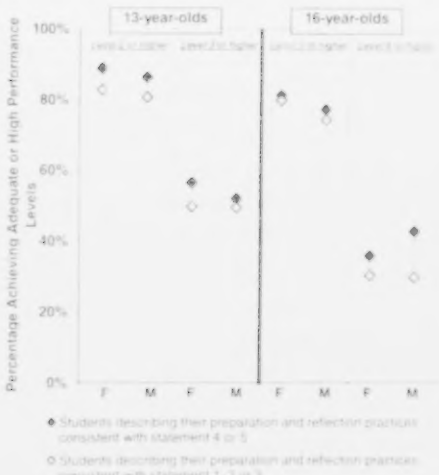
Students who prepare for class, pay attention in class and reflect upon what they have learned have a better chance of doing well in school than students who do not.

Figure 6-1 shows student responses describing their preparation, participation and reflection practices related to science class. Figure 6-2 shows how students achieved on science tests, based on how they prepare for class, participate in class, and reflect on what they have learned in class.

Figure 6-1: Student Preparation and Reflective Practices, 1999 Provincial Opportunity-to-Learn Student Survey

For most science classes, which one of the following choices best describes what you do?	Frequency (%) of Student Responses		
	Grade 5	Grade 8	Grade 11
Statement #1 – I am not prepared for class and pay little attention to the science class activities.	7.9	1.1	2.0
Statement #2 – I am sometimes prepared for class and try to pay attention, but I am often distracted or become bored and stop focussing on the class activities.	23.7	13.0	12.1
Statement #3 – I am usually prepared for class and I try to work in class, but I rarely think about what I did in class, on my own time.	44.3	46.3	53.9
Statement #4 – I come prepared for class and participate in the science class activities. I often think about what I have done in class and how I might improve my understanding.	16.9	34.5	29.0
Statement #5 – I regularly set and review goals for what I want to learn. I participate in the class activities and regularly check to see how well I am doing or how I might improve to achieve my goals.	7.1	5.1	3.0
Standard: Statement #	**4**	**3.69**	**3.94**
% of students meeting the standard	**24%**	**54%**	**35%**

Figure 6-2: Student Achievement by Preparation, Participation and Reflection Practices (Statements 4 or 5 and Statements 1, 2 or 3) on Science Tests, 1999 Provincial Opportunity-to-Learn Survey



Figures 6-1 and 6-2 show that:

- Students are expected to come prepared for class and to participate in class. Most standard-setters believed students should often reflect on what they have done in class, particularly those setting standards for Grade 5 and 11 students.
- About one-quarter of Grade 5 students, one-half of Grade 8 students, and one-third of Grade 11 students met the standard corresponding to their grade. About 85 percent of Grade 8 and 11 students and two-thirds of Grade 5 students are usually prepared for class and try to work in class.
- Overall, those who prepare well for class, participate in class and reflect on how they might improve achieved higher performance levels, although some differences are marginal.

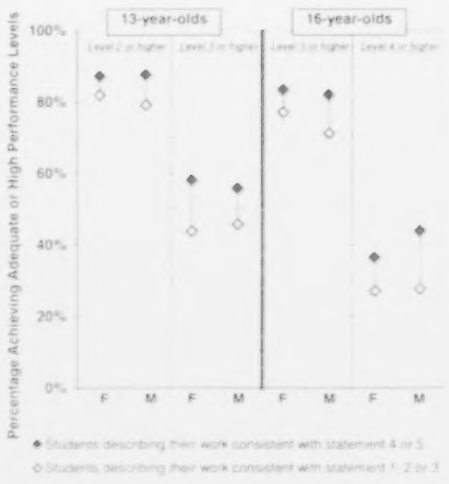
STUDENT PERSISTENCE AND QUALITY OF WORK

Persistence refers to a student's ability to stick with a task until it is completed and the student feels that it reflects his or her very best work.

Figure 7-1 shows how students responded to statements describing completion of assignments and the quality they exhibit in their work. The accompanying Figure 7-2 compares science test outcomes between those students whose persistence and quality of work approximate the standard and those students whose work practices are below the standard.

Figure 7-1: Student Persistence and Quality of Work, 1999 Provincial Opportunities to Learn Student Survey

When doing science assignments, which one of the following choices best describes what you do?	**Frequency (%) of Student Responses**		
	Grade 5	**Grade 8**	**Grade 11**
Statement #1 – I rarely complete my assignments.	3.9	2.0	3.3
Statement #2 – I complete short assignments or assignments that interest me, but often do not work hard to complete difficult or boring assignments.	16.8	10.2	12.4
Statement #3 – I complete most assignments, even difficult or boring ones, but I usually do only as much work as necessary to get them done. I could do much better.	7.9	34.8	38.5
Statement #4 – I complete most assignments, even the ones I find difficult or boring, and I usually work hard to show my best work.	57.5	49.5	44.3
Statement #5 – Not only do I complete all my assignments as well as I can, I also do science activities on my own time.	13.9	3.6	1.5
Standard: Statement #	**4.19**	**4**	**3.94**
% of students meeting the standard	**61%**	**53%**	**48%**



Figures 7-1 and 7-2 show that:

- Teachers, administrators and parents expect students to show their best work while completing most science assignments. Over 60 percent of Grade 5 students, and about half of Grade 8 and 11 students met this standard.
- The majority of all students reported that they complete most assignments, although over one-third of Grade 8 and 11 students indicated they could do much better in their work.
- Overall, males and females who met the standard for persistence and quality of work achieved higher levels than did their counterparts.

WHAT DO YOU THINK?

- How do these results for student readiness and commitment to learn compare to those of our students?
- What is the purpose of having students complete science homework?
- Should students of varying ability do similar amounts of homework? Should we vary the type of homework based on students' ability?
- What quantity of homework do we expect from our students? What quantity of work should be done in the classroom? What quality of work do we expect?
- Are there specific modeling or instructional processes that we can use to assist students in preparation, goal setting, attentiveness and reflection?
- Why does persistence and quality of work decline as students get older? How can we work with students and parents to ensure that students persist to do their best work and maintain that persistence throughout their education?
- Fewer Grade 11 students than Grade 5 or 8 students met expectations for amount of science homework done. This may be because many Grade 11 students are working part-time and involved in social activities. What implications might this have for our expectations?
- Are any of the student outcome comparisons shown in Figures 5-2, 6-2 or 7-2 surprising? What other factors might explain the presence or absence of achievement differences?

FAMILY SUPPORT-RELATED OPPORTUNITIES TO LEARN

Family support and encouragement plays a key role in students' success at school.

Family support-related opportunities to learn considered were:

- home support for students' learning in science (Figure 8-1); and,
- home support for students' learning, in general (Figure 9-1).

- **Family support for science learning is higher at Grades 5 and 11 than at Grade 8.**
- **Family support for learning (overall) declines from Grade 5 to Grade 8 to Grade 11. At Grade 5, seventy-two percent of students reported support consistent with the standard; at Grade 11, this figure had declined to 35 percent.**

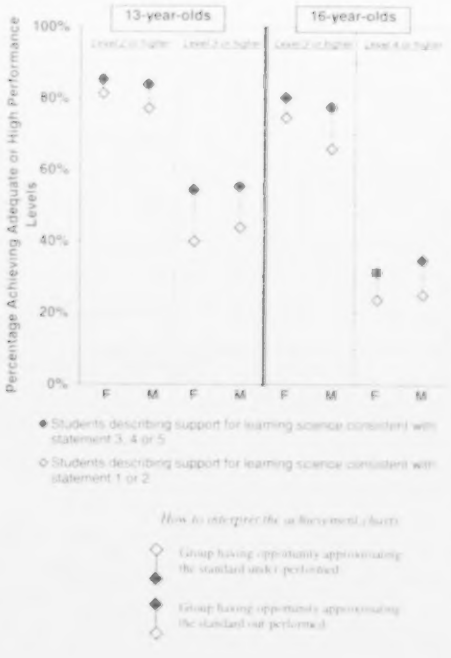
HOME SUPPORT FOR STUDENTS' LEARNING IN SCIENCE

Figure 8-1 shows the question that appeared on the Grade 8 and 11 student survey. To make the language and concepts easier to understand, data was collected differently from Grade 5 students (as noted below the table). The standard-setting panel considered the nature of statement #2 to be quite different than the other four statements.

Figure 8-1: Home Support for Students' Learning in Science, 1999 Provincial Opportunity-to-Learn Student Survey

Which one of the following choices best describes how people in your home support your learning, in science?	Frequency (%) of Student Responses		
	Grade 5	Grade 8	Grade 11
Statement #1 – They show no interest in science and how I learn science.	9.9	9.9	17.6
Statement #2 – They expect me to accept their view of science and the world.	-	9.6	7.0
Statement #3 – They rarely talk to me about science, but make sure I have books, magazines, equipment or computers at home, the school or library to help me as I learn science.	25.5	37.5	39.2
Statement #4 – They encourage me to ask questions related to science and to seek answers, but do not work with me as I try to find the answers.	17.5	26.2	25.2
Statement #5 – They frequently encourage me to ask questions related to science and give direction, as needed, to design ways or find resources to explore answers to my questions.	36.4	16.8	11.0
Standard: Statement #	**3.38**	**3.75**	**3.17**
% of students having support consistent with the standard	**70%**	**52%**	**69%**

Note: Student questionnaire data was collected differently for Grade 5. When Grade 5 data was compiled, it could not be matched with the description in statement #2. Instead, about 11 percent of the compiled data represented support higher than that characterized by statement #1 but lower than that indicated by statement #3.



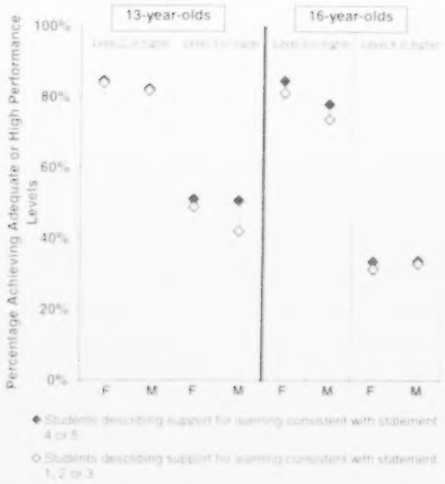
Figures 8-1 and 8-2 show that:

- To sufficiently support their children in learning science, parents are expected to make sure their children have access to resources and should encourage them to ask questions related to science and to seek possible answers.
- About 70 percent of Grade 5 and 11 students felt they had support consistent with the standard. Just over half the Grade 8 students indicated sufficient support consistent with the higher standard set for this grade.
- As a group, more 13- and 16-year-olds who indicated sufficient family support achieved higher levels on the 1999 science tests than those who received less support.

[illegible]

Students' results describing their family's level of support for learning in general appear in Figure 9-1. Figure 9-2 compares student achievement outcomes for the 1999 SAIP science written and practical tests, based on how their learning is supported by their family.

Which one of the following choices best describes how people in your home support your learning, in general?	**Frequency (%) of Student Responses**		
	Grade 5	**Grade 8**	**Grade 11**
Statement #1 – They never ask me or talk with me about how things are going at school.	0.5	3.1	9.2
Statement #2 – They are only interested in how I am doing in school when things aren't going well, often getting upset with me.	7.9	8.7	11.7
Statement #3 – They do not often talk with me about how things are going at school; but I know they are interested in my learning and would be willing to help, if I need help.	1.3	23.6	28.3
Statement #4 – They often talk with me about how things are going at school, and encourage me whether things are going good or bad.	18.7	39.7	36.9
Statement #5 – They regularly talk with me about how things are going at school, and try to help me or arrange for help, if I need it.	71.6	24.8	18.7
Standard: Statement #	**5**	**4**	**4.56**
% of students having support consistent with the standard	**72%**	**65%**	**35%**



Figures 9-1 and 9-2 show that:

- Standard-setters at the various grades differed in the level of support they believed students in that grade should receive from their families. It is expected that parents talk regularly with their children about their school experiences and

encourage them in their progress. Grade 5 and some Grade 11 panelists also expected parents to try to help, or arrange for help, to assist their children in their studies.

- The support received from home for learning declines as students reach the higher grades. Almost three-quarters of Grade 5 students received support consistent with the standard; 35 percent of Grade 11 students reported the expected level of support.
- Those students receiving lower levels of family support performed similar to those receiving higher levels of support, in the 1999 science tests.

- Older students report less family support for learning in general than younger students. Do older students need less support than younger? How might lower levels of family support affect students' aspirations for post-secondary education and careers?
- Does lower family support for learning at Grade 11 explain Grade 11 students' lower persistence and quality of work?
- What are we doing to encourage more parents/families to talk often with their children about their school experiences? What more might we do?
- How can we work with families to help them support their children's learning?

EQUALITY OF OPPORTUNITY TO LEARN IN SCIENCE

Equality of educational opportunity is a major aim of Saskatchewan's school system. This section provides comparisons between:

- female and male students (Figure 10); and,
- rural and urban students (Figure 11).

- **For most student and family support-related opportunity-to-learn elements, a larger percentage of female than male students met the standards.**
- **For most elements, differences between rural and urban learning opportunities were small.**
- **At Grade 11, urban classrooms reported greater availability and use of resources than did rural classrooms.**

GENDER COMPARISONS

	GRADE 5			GRADE 8			GRADE 11		
		% Meeting Standard			% Meeting Standard			% Meeting Standard	
	Standard	Females	Males	Standard	Females	Males	Standard	Females	Males
Student OTL Elements									
Science homework time (hours per week)	0.8	53%	50%	0.9	**51%**	**44%**	1.6	**39%**	**27%**
Preparation/ reflection (Statement #)	4.0	**31%**	**17%**	3.7	**51%**	**56%**	3.9	35%	36%
Student persistence and quality of work (Statement #)	4.2	**66%**	**55%**	4.0	**58%**	**48%**	3.9	**55%**	**41%**
Family Support OTL Elements									
Support at home for learning science (Statement #)	3.4	**66%**	**57%**	3.8	54%	51%	3.2	**72%**	**66%**
Support at home for learning in general (Statement #)	5.0	**75%**	**68%**	4.0	67%	62%	4.6	**39%**	**31%**

Note: Percentages bolded and underlined in the table above represent significant differences in the equality of opportunity between the two groups compared (95% confidence). Other differences between the groups are not statistically significant. See appendix for sample sizes.

Figure 10 shows that:

- For most opportunity-to-learn elements, a larger percentage of female students than male students met the standard.
- In particular, more females than males met the standard for persistence and quality of work. At Grade 5, the difference between females and males was 11 percent, expanding to 14 percent at Grade 11.

RURAL AND URBAN COMPARISONS

Results for rural and urban students were compared for all opportunity-to-learn elements considered. These results appear in Figure 11.

Figure 11: Rural/Urban Comparisons for Saskatchewan Students' Opportunities to Learn in Science: 1999 Provincial Opportunity-to-Learn Teacher and Student Surveys

	GRADE 5			GRADE 8			GRADE 11		
		% Meeting Standard			% Meeting Standard			% Meeting Standard	
	Standard	Rural	Urban	Standard	Rural	Urban	Standard	Rural	Urban
Classroom OTL Elements									
Hands-on activities (# of times per week)	1.2	86%	71%	1.4	79%	70%	4.0	2%	5%
Curriculum implementation (Statement #)	4.1	58%	32%	4.1	53%	43%	4.0	86%	84%
Instructional approaches (Statement #)	4.9	28%	21%	5.0	29%	21%	4.9	25%	32%
Availability and use of resources (Statement #)	4.1	46%	27%	4.3	55%	43%	4.4	**48%**	**64%**
Student OTL Elements									
Science homework time (hours per week)	0.8	52%	50%	0.9%	45%	49%	1.6%	**31%**	**38%**
Preparation/reflection (Statement #)	4.0	24%	25%	3.7	53%	55%	3.9	**33%**	**40%**
Student persistence and quality of work (Statement #)	4.2	60%	62%	4.0	52%	54%	3.9	48%	47%
Family Support OTL Elements									
Support for learning in science (Statement #)	3.4	**65%**	**56%**	3.8	**49%**	**55%**	3.2	68%	71%
Support for learning in general (Statement #)	5.0	**75%**	**68%**	4.0	62%	66%	4.6	33%	38%

Note: Percentages bolded and underlined in the table above represent significant differences in the equality of opportunity between the two groups compared (95% confidence). Other differences between the groups are not statistically significant. See appendix for sample sizes.

Figure 11 shows that:

- For most classroom-related elements, rural classrooms had equal or better opportunity than did urban classrooms. The exception was in availability and use of resources at Grade 11.
- For most student-related opportunity-to-learn elements, a larger percentage of urban than rural students met the standard. Higher percentages of urban than rural Grade 11 students spent time at home working on science and reflected more often on what they learned in science class.
- For family support-related opportunity-to-learn elements, a higher percentage of rural than urban Grade 5 students met the standards for how their family supported their learning. At Grades 8 and 11, the pattern was reversed with more urban than rural students reporting a higher level of family support.

WHAT DO YOU THINK?

- Females report greater support at home for learning in general than do males. Do families support females and males differently? Does this have implications for students' learning?
- What can we do to ensure that both genders receive equal support?
- Greater percentages of females than males met the standards for most indicators of readiness and commitment to learn. What can we do to encourage more male students to persist, spend more time doing science homework, and produce high-quality work?
- Rural classrooms had equal or better opportunity-to-learn results than did urban classrooms, except for availability and use of resources at Grade 11. Is this more an availability or use question? Does our school have sufficient resources and do we use them?
- Why might Grade 11 students in the city spend more time than those in rural settings working at home on science, and thinking about how they might improve their learning in science?
- How can we equalize opportunity to learn for rural and urban students?
- At Grade 5, rural students reported more family support for learning than urban students. At Grades 8 and 11, urban students reported equal or greater family support than rural. What might explain these findings?

CHANGES IN LEARNING SCIENCE SINCE 1993

Grade 5 science questionnaire data collected in 1999 allow for some comparisons and follow-up of data collected and recommendations made in the *1993 Elementary Science Grades 1-5 Curriculum Evaluation*. This section provides information on:

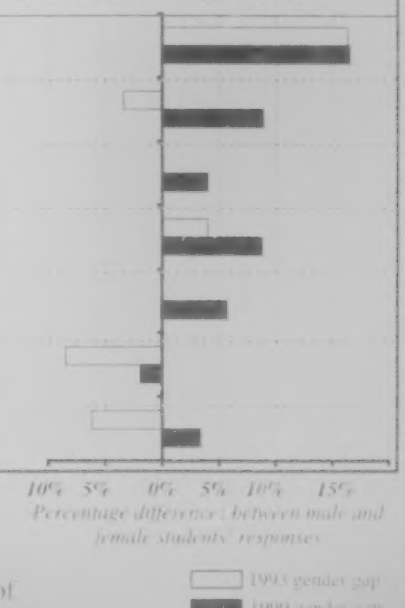
- Grade 5 students' attitudes toward science (Figure 12);
- Grade 5 students' learning experiences in science (Figure 13); and,
- progress in light of the *1993 Curriculum Evaluation* recommendations (Figure 14).

Since 1993:

- **Students' attitudes related to science have improved, and students more frequently use activities and resources to learn science.**
- **Progress related to the 1993 Evaluation recommendations has been limited.**

Figure 12: Grade 5 Students' Attitudes Toward Science, Male/Female Comparisons, 1993 and 1999

Grade 5 students who ...	1993		1999		Gender Differences in Attitudes Toward Science
	Agree[1] (%)	Unsure (%)	Agree[1] (%)	Unsure (%)	*% differences favouring males* / *% differences favouring females*
like most school subjects	68.4	17.4	65.0	23.1	
like to study science in school	48.9	23.4	59.9	21.0	
think it is important to study science	84.0	10.4	82.8	12.1	
think science is useful in everyday life	56.1	27.7	66.7	23.1	
think what they learn in science will be useful in the future	69.8	22.9	80.3	16.1	
find science easy	43.4	34.6	68.0	22.0	
find science exciting	58.9	21.9	64.2	21.6	



Note: [1] This category combines students who strongly agree and those who agree.

Figure 12 shows that:

- From 1993 to 1999, there was a significant increase in the percentage of Grade 5 students who like to study science in school, find science easy to understand, and consider science to be useful both in everyday life and in preparing them for the future.
- More female than male students like most school subjects (16 percent difference). In 1993, similar proportions of females and males showed positive attitudes related to science. Figures for 1999 indicate females' attitudes related to science have improved more dramatically than those of males.

Time spent in science instruction in 1999 was similar to that reported by teachers in 1993. About three-quarters of Grade 5 teachers spend at least 100 minutes per week in science instruction; all teachers report spending more than 50 minutes per week. Figure 13 shows student responses to questions about science activities in their classrooms.

Figure 13: Grade 5 Students' Learning Experiences in Science, 1993 and 1999

How often Grade 5 students ...	1993		1999	
	At least once a week[1] (%)	Never (%)	At least once a week[1] (%)	Never (%)
"do" science in school	95	1	92	2
do science activities in science class	51	8	59	8
watched science TV programs in science class	13	46	12	43
used a science textbook in science class	70	13	55	23
used the resource centre for learning science	20	43	32	36
used a computer for science[2]	14	74	13	61
read the newspaper in science class[3]	17	83	21	79
went on science field trips[3]	44	56	56	44

Note: [1] At least once-a-week category applies to the first five activities. [2] Computer use figures refer to at least once a month frequency. [3] Newspaper reading and field trips refer to at least once a year frequency.

Figure 13 shows that:

- While there have not been dramatic changes from 1993 to 1999, fewer Grade 5 students report use of science textbooks and more report use of science activities and resources.

A number of recommendations were made in the 1993 Elementary Science Curriculum Evaluation report. Figure 14 lists these recommendations and shows data from teacher responses related to these recommendations.

Figure 14: Progress Related to Recommendations of the 1993 Elementary Science Curriculum Evaluation

Recommendation ...	Descriptor	Percent of Teachers 1993	1999
... Teacher preparation and in-service			
Establish requirement of at least one elementary science methods course to obtain an elementary education degree	Taken one or more elementary science classes	79%	77%
Continue to offer curriculum-based science short courses in cooperation with the STF	Available to teacher in the past two to three years	-	21%
Continue to encourage sponsorship of science-related workshops such as SEEDS and Project WILD	Available to teacher in the past two to three years	-	62%
Follow-up in-service should focus on developing unit plans in science and experiencing performance-based activities	Available to teacher in the past two to three years	-	28%
Provide support and suggestions for teaching in multi-graded situations	Available to teacher in the past two to three years	-	11%

Recommendation ...	Descriptor	Percent of Teachers 1993	1999
... Teacher preparation and in-service			
Encourage teacher networking in science	Available to teacher in the past two to three years	–	38%
Produce an annual update for teachers and administrators on new developments and resources to support the elementary science curriculum	Available to teacher in the past two to three years	–	34%
... Instructional planning and practice			
Ensure every teacher of elementary science has a copy of the curriculum guide and curriculum support documents	Teacher has personal copy of the curriculum guide	75%	77%
Ensure conciseness and ease of use of the curriculum guide	Teacher describes curriculum guide as easy to follow/understand	70%	81%
Give students opportunities to strengthen and expand observing, describing, analyzing, hypothesizing and questioning skills	Opportunity provided at a medium-to-high frequency	–	94%
Maintain an activity-based focus in science classrooms	Opportunity provided at a medium-to-high frequency	–	74%
Include performance tasks in student evaluation practices	Opportunity provided at a medium-to-high frequency	–	91%
Emphasize Common Essential Learnings in science teaching and learning:			
Communications	Teacher emphasized these Common Essential Learnings in the last science unit taught	76%	79%
Critical and Creative Thinking		90%	85%
Independent Learning		80%	89%
Numeracy		54%	53%
Personal and Social Values and Skills		62%	51%
Technological Literacy		55%	57%
... Support for teaching science		Percent of Schools	
Designate one person in the school to be responsible for science resources, materials and information	School has a "science resource person"	15%	3%
Continue financial support to maintain the elementary science curriculum	School has medium-to-high budget support	66%	62%

Notes: Percentages indicating support for teaching science (last two rows) are calculated from school-based administrator responses. All other percentages are calculated from teacher questionnaire responses. The dashes (–) in some entries of the 1993 column indicate no information is available for these items in 1993.

Figure 14 shows that:

- There has been little significant change from 1993 to 1999 in teacher preparation and in-service, instructional planning and practices, and support for teaching science
- Overall, four-fifths of teachers reported availability of science in-service of some kind. Only 11 percent indicated opportunity to receive support or suggestions for teaching in multi-graded situations, but more reported availability of various science-related workshops (62 percent).
- Just over 60 percent of schools reported having a sufficient budget to support the elementary science curriculum; only 3 percent of the schools had a designated "science resource person".

APPENDIX: SAMPLE SIZES

The table below shows the number of participants in each assessment component. The table groups the numbers for related figures displayed throughout the report. These numbers are useful for determining the significance of any differences shown in the figures.

	n
Figures 1-1 to 4-1	
Grade 5 teachers	47
Grade 8 teachers	351
Grade 11 teachers	253
Figures 5-1 to 9-1	
Grade 5 students	941
Age 13 students	1727
Age 16 students	1663
Figures 1-2 to 4-2	
Note: For these figures, data is available only for the written science test.	
Age 13 female students	423
Age 13 male students	458
Age 16 female students	450
Age 16 male students	414
Figures 5-2 to 9-2	
Note: For these figures, data is available for the practical and written science tests.	
Age 13 female students	796
Age 13 male students	873
Age 16 female students	828
Age 16 male students	786
Figure 10	
Grade 5 female students	450
Grade 5 male students	489
Age 13 female students	796
Age 13 male students	873
Age 16 female students	828
Age 16 male students	786

	n
Figure 11	
Grade 5 rural teachers	25
Grade 5 urban teachers	20
Grade 8 rural teachers	152
Grade 8 urban teachers	182
Grade 11 rural teachers	119
Grade 11 urban teachers	116
Grade 5 rural students	514
Grade 5 urban students	380
Age 13 rural students	776
Age 13 urban students	889
Age 16 rural students	1056
Age 16 urban students	565
Figures 12 and 13	
Grade 5 students (1993)	2939
Grade 5 female students (1993)	1437
Grade 5 male students (1993)	1462
Grade 5 students (1999)	941
Grade 5 female students (1999)	450
Grade 5 male students (1999)	489
Figure 14	
Grade 5 teachers (1993)	184
Grade 5 schools (1993)	171
Grade 5 teachers (1999)	47
Grade 5 schools (1999)	30